9.51 An eight-element linear array with $\lambda/2$ spacing is excited with equal amplitudes. To steer the main beam to a direction 60° below the broadside direction, what should be the incremental phase delay between adjacent elements? Also, give the expression for the array factor and plot the pattern.

Solution: Since broadside corresponds to $\theta = 90°$, 60° below broadside is $\theta_0 = 150°$. From Eq. (9.119),

$$\delta = kd\cos\theta_0 = \frac{2\pi}{\lambda}\frac{\lambda}{2}\cos 150° = -2.72\ (\text{rad}) = -155.9°.$$

Combining Eq. (9.121) with (9.122) gives

$$F_{\text{an}}(\theta) = \frac{\sin^2\left(\frac{1}{2}Nkd\left(\cos\theta - \cos\theta_0\right)\right)}{N^2\sin^2\left(\frac{1}{2}kd\left(\cos\theta - \cos\theta_0\right)\right)} = \frac{\sin^2\left(4\pi\left(\cos\theta + \frac{1}{2}\sqrt{3}\right)\right)}{64\sin^2\left(\frac{1}{2}\pi\left(\cos\theta + \frac{1}{2}\sqrt{3}\right)\right)}.$$

The pattern is shown in Fig. 9.51(b).

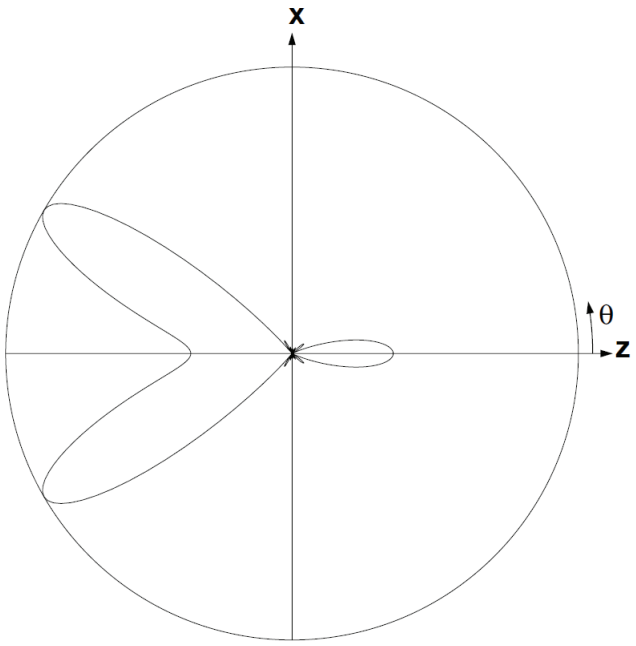

Figure P9.51: Pattern of the array of Problem 9.51.